Western Trauma Association Critical Decisions in Trauma: Management of complicated diverticulitis

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HISTORICAL PERSPECTIVE

Diverticulosis is a common problem in developed countries. Its incidence increases with age, ranging from 30% to 50% in individuals older than 50 years and more than 65% in those older than 80 years. One fourth (25%) will develop "complicated diverticular disease," defined as diverticulitis associated with phlegmon, abscess, fistula, stricture presenting with obstruction, or perforation with peritonitis. There is surprisingly little high-grade evidence on which to draw firm recommendations. Most of what we know comes from retrospective case series dating back more than 100 years.[1] The first resection for perforated diverticulitis with peritonitis was by Mayo et al.[2] in 1907. However, in a subsequent report from the Mayo clinic in 1924, Judd and Pollock[3] concluded that primary resection was too difficult in the acute setting, and stirring up the infection resulted in a very high mortality. This was in the preantibiotic era, and their suggested procedure was a colostomy with irrigation of the distal colon and then delayed resection as the patient tolerated. In 1942, Smithwick[4] reported the Massachusetts General Hospital experience comparing different operations that had been performed at that institution, and he concluded that the best early mortality and long-term outcomes were achieved with preliminary proximal colostomy and then resection in 3 to 6 months after the inflammation had resolved. The three-stage procedure then became the standard of care. The first operation was a diverting transverse colostomy and drainage. The second operation (performed 3 to 6 months later) was definitive resection and colostomy. The third operation (performed 3 to 6 months after the second) was colostomy closure. Starting in the late 1950s, a case series emerged that demonstrated, with the advent of preoperative antibiotics, that in select cases, the diseased colon could be safely resected. In 1984, Krukowski and Matheson[5] reviewed the mortality in 36 case series published from 1957 to 1984 that had compared the use of resection versus colostomy with no resection. These reports included 821 cases of diverticulitis with purulent or fecal peritonitis, of which 316 patients underwent acute resection with a mortality rate of 12% compared with a mortality rate of 29% in the 505 patients who underwent colostomy with no resection. Of course, these case series suffer from selection bias in that healthier patients were more likely to undergo acute resection and the less healthy were more likely to receive a colostomy. However, this report did show that, with antibiotics and better supportive care, a substantial portion of patients can undergo acute resection with a more acceptable mortality rate. In addition, advocates argued that acute resection avoids missing a colon cancer (which occurred in 2–7% of the cases) and decreases morbidity because up to 20% of the nonresected patients will ultimately develop a fistula. Interestingly, there are two prospective randomized controlled trials comparing acute resection with colostomy for perforated sigmoid diverticulitis that show divergent results. In a single-center study from Denmark published in 1993, 62 patients were operated on for peritonitis secondary to diverticulitis, and of those, 46 patients were found to have Hinchey III purulent peritonitis (i.e., no hole in the colon).[6] Twenty-one were randomized to colostomy with no resection, and all survived. Of the 25 patients randomized to acute resection, six (24%) died. In contrast, a 2000 report of a multicenter French prospective randomized controlled trial included 103 patients with (Hinchey III) purulent and (Hinchey IV) fecal peritonitis.[7] Forty-eight of these patients were randomized to colostomy (with suture closure of the hole in the colon for the Hinchey IV cases). Their postoperative peritonitis rate was high at 20%, with a mortality rate of 18%. In contrast, in the 55 patients randomized to acute resection, the postoperative peritonitis rate was significantly lower at less than 2%, and they had a similar mortality rate of 23%. In 2000, the American Society of Colon and Rectal Surgeons revised their practice parameters for treatment of sigmoid diverticulitis.[8] Based on their expert review of the data, they concluded that for perforated diverticulitis with peritonitis, the procedure of choice was a segmented resection with end colostomy (i.e., a Hartman procedure). However, in 2006, Constantinides et al.[9] published a systematic review of 15 comparative studies (13 retrospective, 2 prospective nonrandomized) published from 1984 to 2004 that compared primary resection with anastomosis (PRA) with that of the Hartman's procedure (HP) for emergency surgery for acute diverticulitis. The meta-analysis of these data showed that for the subgroups with diverticular disease with abscess and diverticular disease requiring an emergency operation, mortality was improved in those patients who underwent PRA compared with that in those who underwent the HP. In addition, for surgical complications (including wound infections, abscesses, and peritonitis), there was a trend toward improved outcomes favoring PRA over the HP. Again, this review of primarily retrospective case series suffers from selection bias, where the healthier people undergo PRA and the not so healthy receive a colostomy. However, what these data do show is that (1) emergency PRA in select patients has a low rate of anastomotic leak rate of roughly 6%; (2) PRA and the HP had similar operative times; and (3) for the sicker patients (Hinchey > II subset), PRA and the HP had equivalent mortality (14.1 vs. 14.4%). As a result of these emerging data, in 2006, the American Society of Colon and Rectal Surgeons updated their practice parameters for sigmoid diverticulitis.[10] They concluded that urgent sigmoid resection is required for perforated diverticulitis with peritonitis, and the alternatives to the HP include primary anastomosis with or without interoperative lavage, and the precise role of primary anastomosis (especially without diversion) remains unsettled. Interestingly, as the American Society of Colon and Rectal Surgeons has been endorsing an increasingly more aggressive approach, there have been at least 11 case series with more than 301 patients since 1996 that document surprisingly good results with laparoscopic lavage and drainage.[11] In 2008, Myers et al.[12] reported the best series to date. Of 1,257 patients admitted for diverticulitis within 7 years, 100 (7%) had peritonitis, with evidence of free air on roentgenogram or computerized tomographic (CT) scan. These patients were resuscitated, given a third-generation cephalosporin and flagyl, and then taken emergently to the operating room (OR) for laparoscopy. Of the 100 patients who underwent laparoscopy, eight were found to have Hinchey IV disease and underwent the HP. The remaining 92 Hinchey II and III patients underwent lavage and drainage. Three of these patients died (much lower than reported for PRA or the HP). An additional two patients had nonresolution, one went on to have the HP performed,

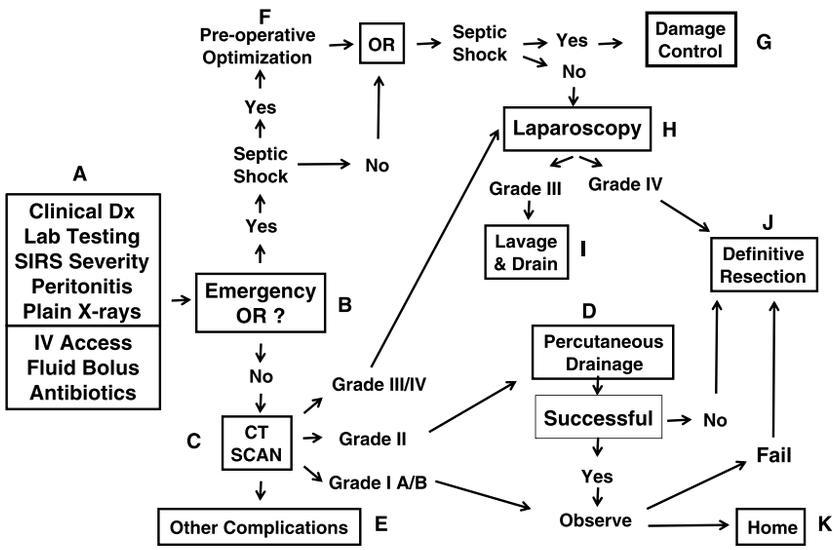

Figure 1. Management algorithm for complicated diverticulitis (n.b. the letters in the algorithm above correspond to sections in the main text of this article).

and the other one had further percutaneous drainage. Overall, 88 of the 92 lavage patients had resolution of their symptoms. They were discharged to home and were not offered a delayed definitive resection. During the 36 months of follow-up, there were only two recurrences. This series challenges our basic understanding of the natural history of diverticulitis. It is surmised with resolution of an acute perforation; local fibrosis prevents the recurrent perforation of the diverticulum. Given this information, it is time to rethink how we care for these very difficult patients.[13–15] The purpose of this article is to provide a practice algorithm for acute care surgeons to use and frame research questions (Fig. 1).

A. INITIAL ASSESSMENT

Abdominal pain is the primary presenting symptom of diverticulitis. It is typically located in the left lower quadrant; however, a redundant sigmoid colon can reach the right lower quadrant and mimic appendicitis. Localized peritoneal irritation can result in guarding and rebound tenderness. Free perforation often presents as frank peritonitis. Fever and leukocytosis are frequently present and assist in making the clinical diagnosis. Nausea and vomiting are the most notable symptoms when a stricture results in an obstruction. During the initial clinical assessment, SIRS severity (Table 1), presence of peritonitis, and signs of organ dysfunction drive early decision making. Patients with severe sepsis/septic shock should have adequate intravenous access obtained (at least two large-bore lines), be administered a bolus of crystalloids (generally 20 mL/kg), and be given broad-spectrum antibiotics.[17] A flat plate and an upright roentgenogram of the abdomen are good screening tools to identify evidence of obstruction and/or free air. Initial laboratory testing should include a complete blood cell count and electrolyte, lactate, and coagulation profile (if surgery is anticipated).

TABLE 1. Sepsis Severity Score[16]

	0	1	2	3	4
Heart rate, beats/min	70–109		55–69	40–54	≤39
			110–139	140–179	≤180
Temperature, °C	36–38.4	34–35.9	32–33.9	30–31.9	≤29.9
		38.5–38.9		39–40.9	≥41
Temperature, °F	96.8–101.1	93.1–96.7	89.6–93.0	86–89.5	≤85.9
		101.2–102.0		102.1–105.6	≥105.7
Respiratory rate	12–24	10–11	6–9	35–49	≤5
		25–34			≥50
Latest WBC count	3–14.9	15–19.9	1–2.9		<1
			20–39.9		≥40
Acute change in mental status	No	Yes			
SIRS score (total points)					

If the SIRS score is ≥4, this indicates a possible serious infection.
WBC, white blood cell.

B. EARLY OPERATION

Patients with free air on abdominal roentgenograms or obvious peritonitis should be prepared for the OR. Those in septic shock deserve preoperative optimization.

C. CT SCAN

This has revolutionized the management of diverticulitis because of its high sensitivity and specificity in confirming the diagnosis and identifying those patients who are candidates for therapeutic percutaneous drainage. CT scanning also excludes other causes of left lower abdominal quadrant pain (e.g., leaking abdominal aortic aneurysm or an ovarian abscess) but is not reliable in differentiating acute diverticulitis from colon malignancy. Table 2 depicts a grading system that subdivides diverticulitis based on the extent of disease. The traditionally used Hinchey classification was developed before routine CT scanning, and we have modified it slightly to reflect contemporary management. Grade IA (phlegmon, no abscess) and grade IB (phlegmon with abscess <4 cm) are treated with intravenous antibiotics. There are a variety of choices, but the agent(s) need to provide good coverage for aerobic gram-negative rods and anaerobes (e.g., piperacillin/tazobactam). Those who respond with resolution of pain, fever, and leukocytosis are started on an oral diet and converted over to oral antibiotics, again covering aerobic gram-negative rods and anaerobes (e.g., Levaquin and Flagyl) for a total of 14 days of antibiotics. They can be discharged home (see K. Home). Those who do not respond are taken to the OR for definitive resection (see J. Definitive Resection).

D. PERCUTANEOUS DRAINAGE

Grade II (phlegmon with abscess >4 cm) or those with smaller abscesses that are not responding to antibiotics should be treated by CT-guided percutaneous drainage (PCD).[18] The preferred approach is transabdominal either anterior or lateral, attempting to avoid the inferior epigastric or deep circumflex iliac vessels. Other approaches include transgluteal, transperineal, transvaginal, or transanal. PCD patients are followed clinically, and the decision for surgery is based on progression of disease based on SIRS severity and ongoing organ dysfunction. Reported failure rates for PCD range from 15% to 30%, with a complication rate of 5% (including bleeding, perforation of a hollow viscus, or fistula formation). Patients who fail PDC should undergo the HP. Patients who respond well to PDC should be discharged home (see Home).

TABLE 2. Western Trauma Association Complicated Diverticulitis Score

Grade	Characteristic
IA	Phlegmon with no abscess
IB	Phlegmon with abscess <4 cm
II	Phlegmon with abscess >4 cm
III	Purulent peritonitis (no hole in colon)
IV	Feculent peritonitis (persistent hole in colon)
Other Complications	Stricture or fistula

E. OTHER COMPLICATIONS

Fistulas

Fistulas occur in 2% of patients with diverticular disease, and they occur when the localized inflammatory process develops into an abscess that then decompresses into an adjacent organ. Most patients with a fistula do not require an emergent intervention because the abscess has decompressed. Abdominal symptoms are infrequent. Recurrent urinary tract infection, dysuria, pneumaturia, and fecaluria suggest a colovesical fistula (CVF) and is the most common type of fistula.[19] The poppy seed test is reported to have a sensitivity of 95% to 100% in diagnosing CVF. This involves oral intake of 50 g of poppy seeds mixed in a beverage or yogurt and visual inspection of the urine for 48 hours. Detection of poppy seeds in the urine confirms the diagnosis. Endoscopy of the colon and bladder is of limited value in diagnosing a CVF; its main value is in ruling out malignant disease. Cystoscopy provides additional information about the location of the fistula in relation to the ureteral orifices. At the definitive operation, resect the sigmoid colon (as described in J. Definitive Resection), excise the bladder fistula, close the defect in two layers, and perform a primary colorectal anastomosis. Interpose the omentum between the colon and the bladder. The bladder should be drained with a Foley catheter for 7 days. Colovaginal fistulas occur almost exclusively in women who have undergone previous hysterectomy and frequently seen by a gynecologist with a complaint of vaginal discharge and passing gas per vagina. After a screening colposcopy to rule out cancer, a single-stage sigmoid resection is performed, with pinching of the site of the fistula and interposing omentum. A colocutaneous fistula rarely occurs de novo and is generally seen in patients with a previous incomplete sigmoid resection or a PCD.

Strictures

Strictures generally occur after multiple attacks of diverticulitis and account for approximately 10% of large-bowel obstructions. Small bowel can become an adherent inflamed stricture, leading to small-bowel obstruction. Treatment depends on whether the obstruction is partial or complete. Partial obstruction can resolve with bowel rest, intravenous hydration, and antibiotics, with a delayed definitive resection. Complete obstruction can cause significant dilation in the proximal colon, and this creates a problem when trying to create a colorectal anastomosis. The HP is therefore performed. One recent alternative is to use a colonic stent and allow the compression of the bowel and then perform a delayed one-stage sigmoid resection. Because the strictures tend to be longer and more angulated than cancer, a stenting diverticular stricture is technically difficult and the stents often migrate. This should be embarked on with caution. In patients who are physiologically deranged, the other option is to perform a proximal decompressive colostomy, allow the patient to stabilize, do a colonoscopy to rule out cancer, and then perform a delayed one-stage resection.

F. PREOPERATIVE OPTIMIZATION

This will take 2 to 3 hours to accomplish. The patients are administered a bolus of 20 mL/kg of isotonic crystalloids and given rescue norepinephine as-needed to maintain a mean arterial pressure more than 65 mm Hg. Broad-spectrum antibiotics are administered. At least two large-bore intravenous lines are needed. Given that the patient is in septic shock, a central line (via the internal jugular vein placed under ultrasound guidance) and an arterial line are placed. With ongoing volume loading, CVP is increased to more than 10 cm H_2O. At this point, the patient is intubated. Avoid etomidate as an induction agent because it is known to suppress the adrenal function and its use in critically ill patients is associated with increased mortality.[20] Use ketamine instead because it does not adversely affect cardiac function and it down-regulates proinflammation.[21] Ventilation is then optimized. Norepinephrine is titrated to maintain a mean arterial pressure of more than 65 mm Hg, and if high doses are required, stress dose steroids are administered.[15] Electrolyte abnormalities are corrected, and blood products are administered based on institutional guidelines. Lactate and mixed venous hemoglobin saturations are measured.

G. DAMAGE CONTROL

In the early 1980s, trauma surgeons recognized the high mortality associated with operating in the setting of "bloody vicious cycle" of acidosis, hypothermia, and coagulopathy.[22] This prompted the development of the concept of a truncated laparotomy using packing to stop bleeding with a temporary abdominal closure (e.g., towel clip closure of the skin) and triage to the intensive care unit (ICU), with the intent of optimizing physiology and then returning to the OR after 24 to 48 hours for definitive treatment of injuries and abdominal closure.[23] This concept was initially promoted for major liver injuries but was soon extended to all emergency laparotomies.[24–26]

During the next decade, this concept evolved into "damage control" (DCL), which was a major paradigm shift for trauma surgeons.[27] This practice has become standard of care worldwide and has saved the lives of many patients who previously exsanguinated on the OR table. However, the role of DCL in emergency abdominal surgery is controversial.[28,29] It is often confused with the concept of a "planned relaparotomy." This strategy has been debated for more than 30 years. Reoperations are performed every 48 hours for "washouts" until the abdomen is free of ongoing peritonitis and then the abdomen is closed. This supposedly prevents and/or provides early treatment of secondary infections, thus decreasing late multiple organ failures and deaths. The downside of the planned relaparotomy approach is increased resource utilization and the increased potential risk for gastrointestinal fistulas and delayed hernias. The alternative is referred to as "laparotomy on demand," where relaparotomy is performed for clinical deterioration or lack of improvement. The potential downside to this approach is harmful delays in diagnosing secondary abdominal infections and the presence of more dense adhesions if there is a need to reoperate. Over the years, there have been eight case series that have offered conflicting results regarding the impact of this strategy on outcome. A meta-analysis of the data concluded that "laparotomy on demand" was the preferred approach in patients with APACHE II less than 10.[30] However, a recent prospective randomized trial by van Ruler et al.[31] in patients with APACHE II higher than 10 indicates that the practice of "planned relaparotomy" offered no clinical advantage over "laparotomy on demand" and was associated with substantial increases in expenditure of hospital resources.

The purpose of DCL is to perform a truncated operation to correct immediate life-threatening problems and then triage the patient to the ICU to correct abnormal physiology before returning to the OR for a second definitive operation. In trauma, the life-threatening issue is exsanguinations, and the abnormal physiology is the "bloody vicious cycle" of acidosis, hypothermia, and coagulopathy. Although the "bloody vicious cycle" can occur with intra-abdominal sepsis, exsanguination is uncommon. Rather, patients with grade III or IV complicated diverticulitis can present the "persistent septic shock cycle" (Fig. 2). Initially, they are too sick to undergo immediate operation. In these cases, there has been a paradigm shift (Fig. 3). The traditional approach was to move relatively quickly to the OR for source control by performing the HP. However, septic shock patients, by definition, require vasopressors, and when subjected to general anesthesia, they require higher doses of vasopressors. If the patient undergoes definitive resection HP, the prolonged exposure to high-dose vasopressors causes acute kidney injury (AKI) which sets the stage for multiorgan failure and prolonged ICU stays.[32] The DCL strategy requires preoperative optimization, as described in Preoperative Optimization, which may take 2 to 3 hours. The patient is then moved to the OR, and the surgeon assesses the patient for evidence of physiologic derangement, including acidosis, evidence of disseminated intravascular coagulation, and/or the need for vasopressors. If the patient is judged to be physiologically deranged, the surgeon informs the OR team that a DCL is going to be performed. A limited colon resection of the inflamed colon is performed using staplers, with no colostomy, and a temporary abdominal closure is performed. The patient is returned to the ICU for ongoing resuscitation. Once physiologic abnormalities are corrected, the patient is returned to the OR for peritoneal lavage and colostomy formation.

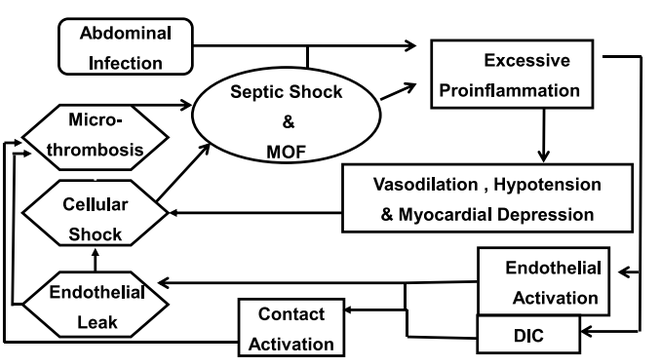

Figure 2. The persistent septic shock cycle.

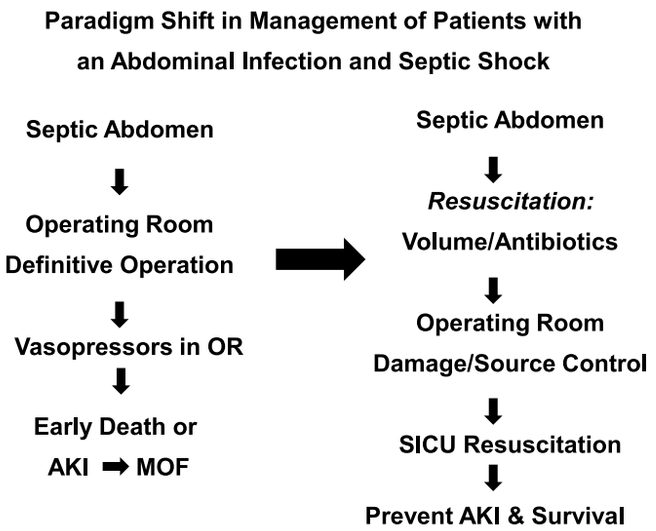

Figure 3. Paradigm shift in management of patients with an abdominal infection and septic shock.

H. LAPAROSCOPY

Recent case series have demonstrated that grade III complicated diverticulitis can be successfully treated by laparoscopic washout and drainage. For the patient who is not in septic shock, this should be pursued. Patients who have grade IV diverticulitis should undergo definitive resection (see Definitive Resection).

I. LAVAGE AND DRAIN

Pneumoperitoneum is established using an open technique to place a 12-mm umbilical port. Two 5-mm ports are placed in the suprapubic and right lower quadrant to assist with manipulation and lavage. The abdomen is thoroughly inspected without vigorous manipulation of the inflamed colon. If there is no evidence of free perforation of the colon (i.e., fecal peritonitis), the four quadrants of the abdomen are lavaged until the drainage is clear. A closed suction flat drain is placed in the pelvis and brought out of the right lower quadrant port.

J. DEFINITIVE RESECTION

This requires mobilization of the sigmoid colon with avoidance of injury to the ureters. Ureteral stents should be used selectively in those patients with abscesses or excessive inflammation in the pelvis. The distal margin of resection should be the upper rectum, whereas the proximal margin of resection should go back to the noninflamed descending colon. All diverticuli do not need to be resected. The splenic flexure is generally not mobilized. As discussed in the Historical Perspective, the major current debate is whether to perform a PRA or to perform the HP. Another unresolved debate is if a PRA is performed, should a protecting diverting ileostomy be added?

Unless conditions are optimal, this is the prudent thing to do. The use of perioperative colonic lavage seems to lower complications with PRA, but the supporting evidence is limited. Omentoplasty does not offer any benefits. For patients who have undergone limited resection in a previous DCL and are returning for their second operation, a definitive resection should be done if feasible. Then the debate is whether to do primary anastomosis. There are limited data in the diverticulitis literature on which to make this decision. In the trauma literature, the results of delayed colon anastomosis are quite variable, with anastomotic leak rates varying between 12% and 30%.[33–35] Again, this decision is individualized based on presenting physiology, the condition of the bowel, patient comorbidities, surgeon experience, and hospital factors.

K. HOME

After recovery from a new onset of diverticulitis, the patient should undergo a colonoscopy or, alternatively, a barium enema to rule out an alternative diagnosis, most importantly, carcinoma. These studies should be obtained after acute inflammation has resolved. There is no clear guideline for who should undergo an elective prophylactic colectomy. The following is a recommended list:

- Based on decision analysis models, the preferred timing of elective surgery to optimize life expectancy is after the third or fourth episode of uncomplicated diverticulitis.
- Transplant patients or patients with chronic diseases affecting their immunity, including chronic use of steroids, should be offered a colectomy after a documented case of diverticulitis.
- Patients with an episode of complicated diverticulitis with persistent or recurrent symptoms or immunocompromised or young.
- Patients with complicated diverticulitis who have an anatomic deformity, including a stricture or fistula.

The timing of this elective colectomy is debated on but, generally, one waits 4 to 6 weeks to allow the inflammation to subside. Laparoscopy is preferred over open colectomy in the setting of acute uncomplicated diverticulitis. There are no data concerning laparoscopic versus open surgery for complicated diverticulitis.

AUTHORSHIP

All of the authors participated in creating the management algorithm and writing the manuscript, which was revised based on feedback received from the membership of the Western Trauma Association. All of the authors approve of the final article.

DISCLAIMER

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DISCLOSURE

The authors declare no conflicts of interest.

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